Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy

Abstract Number: 12623

Presented By:

Fred Wellers, RRO,EVP – JBlanco Enterprises, Inc
Juan Gabriel Luna, AIA, NCARB - Principal, Rogue Architecture, Inc.
Christopher Simpson, PE, LEED AP – Engineering Services Mgr, USAFA, 10 CES
Vincent Rossi – Principal, Rossi Engineering

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **JBlanco Enterprises, Inc,4000 S. Federal Blvd Suite A,Sheridan,CO,80110**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 9-12 May 2011 in New Orleans, LA.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**34**	

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623

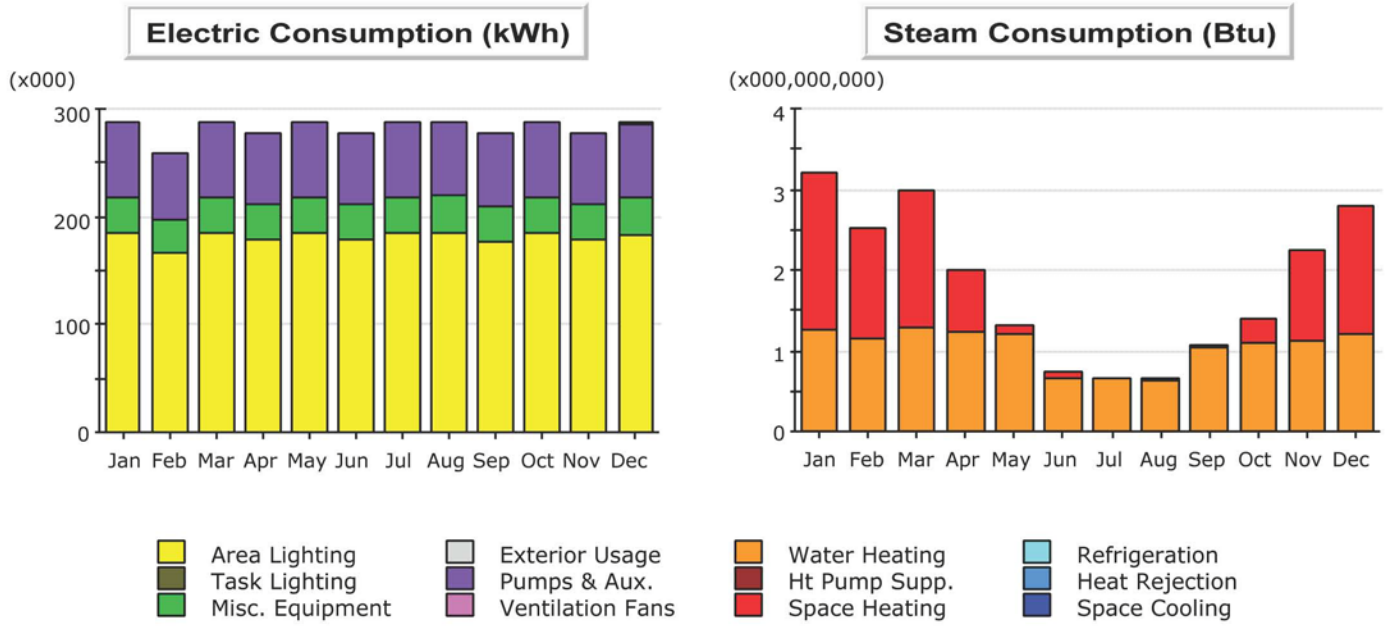
Vandenberg Hall

- Six Stories + Basement
- Quarter of a Mile Long
- Window Wall System – 50 Years Old
- Reduce Energy Consumption

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623

Energy Model



Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Glazing Scenario Modeling

VANDENBERG GLAZING SCENARIO ENERGY MODELING RESULTS

	Glass Scenario 1 Base Design	**Glass Scenario 2** Thermal Performance	**Glass Scenario 3** Non Low-E	**Glass Scenario 4** Existing
Electric Consumption (kWh x 000)	3389.4	3384	3389.9	3417.2
Annual Electric Bill	$ 169,539	$ 169,267	$ 169,562	$ 170,928
Gas Consumption (Btuh x 000,000,000)	23.4	21.57	24.19	40.94
Annual Gas Bill	$ 214,351	$ 197,536	$ 221,618	$ 375,005
Total Consumption (Btu x 000,000,000)	34.96	33.12	35.76	52.60
Total Annual Bill	$ 383,890	$ 366,803	$ 391,180	$ 545,933
Savings compared to *Existing Design*				
Energy Savings	33.53%	37.04%	32.02%	---
(Btu x 000,000,000)	17.63	19.48	16.84	
Annual Dollar Savings	29.68%	32.81%	28.35%	---
	$ 162,043	$ 179,130	$ 154,753	

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

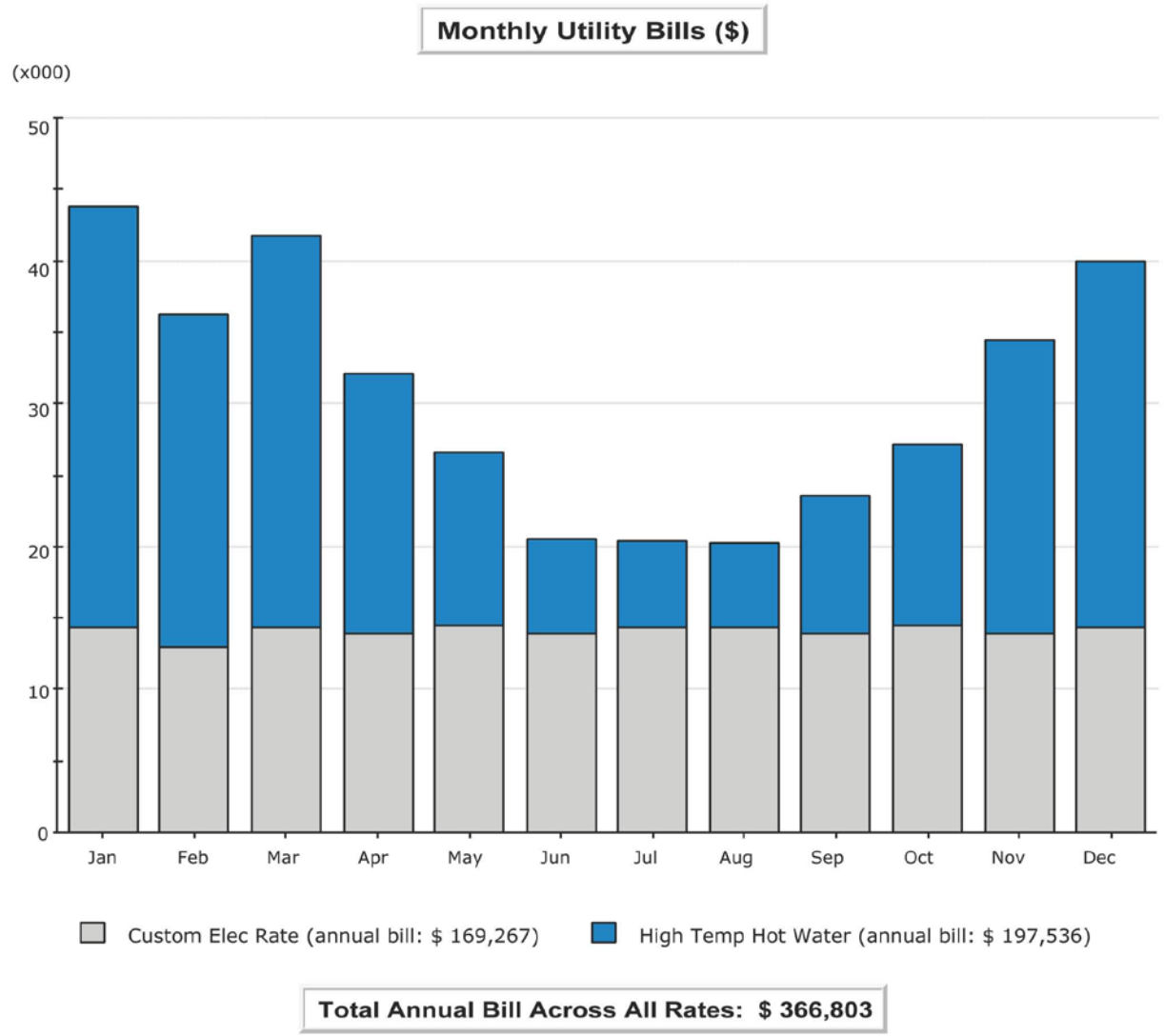
United States Air Force Academy • Abstract Number: 12623

Vandenberg Hall

- Estimated Costs for Utilities - $ 545,933.00 / year
- Scenario 2 Costs for Utilities - $ 366,803.00 / year
- Energy Consumption Reduction by 32.81%
- Energy Conservation – Use of Renewable Energy

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623



Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623

Vandenberg Hall

- Thin Film Solar Array
- Direct Application on Roofing Membrane
- Wind Gusts of 110 mph
- Single Source 25 Year Warranty
- Return On Investment 17 years

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Year	2010	2027	2028
Crude Oil	12.16	20.46	20.77
$ - kW/hr	$ 0.1400	$ 0.2356	$ 0.2391
Total Consump in kWh	2,110,590	2,110,590	2,110,590
Total Energy Cost	$ 295,482.60	$ 497,168.91	$ 504,701.78
RE Production kWh	305,268	257,324	254,751
RE Energy Investment	$ 42,737.59	$ 60,615.04	$ 60,918.11
Non RE Complimentary Production kWh	1,805,322	1,853,266	1,855,839
Non RE Energy Cost	$ 252,745.01	$ 436,553.88	$ 443,783.67
Actual Energy Cost	$ 252,745.01	$ 436,553.88	$ 443,783.67
Amortization of PV Array's Initial Cost (ROI)	$ 962,819.41	$ 2,857.03	$ (58,061.08)
$ 1,005,557.00			
Solar Insolation Value	6.0		

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the

United States Air Force Academy • Abstract Number: 12623

Energy at USAFA

- USAFA commissions leaders of character
  - Mission conducted as balance between built and natural environment
  - Relies on Innovation, Education, Conservation
  - Reduce Demand via Facility Improvement and Policy
  - Innovation in Technology and Application
    - Symbiosis Between Research and Application
  - Educate! Spread the Awareness and Knowledge
    - Involve Cadets in Development of Renewable Energy
  - Civil Engineering is at forefront of this mission

Energy Management Program

- Falcon Green Program
  - Conservation Initiative to Shut-Down Computers at Night:
    - Yielding ~2% Electrical Energy Reduction from 2009
  - USAFA Energy Triad involving 10 ABW, USAFA DF and Cadets kicked-off in July 2010
  - Energy policy implemented – regulates temperature set points; limits personal coffee pots, refrigerators, etc.

Energy Management Program

- American Recovery and Reinvestment Act of 2009 (ARRA)
  - Received $18.3M to develop a Solar Array
- AF's FY10-15 Energy Conservation Focus Fund - $250M per year - $1.5B total
  - FY10 – USAFA first Command/DRU to award 100% of projects
  - FY11 – USAFA slated to receive $2.7M

Conservation Projects Funded Centrally by HAF

- **FY10 Energy Conservation Projects**
  - **Repair Lighting/Cooling Community Center Bldgs**
  - **Repair/Replace Lighting Falcon Athletic Center**
  - **Repair/Replace Lighting Cadet Gym**
  - **Repair/Replace Lighting Fairchild and Sijan Halls**
  - **Repair/Replace Chillers-Fairchild Hall**
- **Estimated Total Annual Energy Savings 7,000 MBTU**

Conservation Projects Funded Centrally by HAF

- **FY 11 Energy Conservation Projects**
  - **Optimize HVAC Harmon Hall**
  - **Lighting retrofit Cadet Chapel & Aero Lab**
  - **Lighting retrofit Airmen's Dining Hall & Enlisted Dorm**
  - **Lighting retrofit Vehicle Maint & Sailplane Hangar**
  - **Optimize EMCS Multiple Buildings**
- **Estimated Total Annual Energy Savings 57,000 MBTU**

Photovoltaic System and Components Phase 1

- Design Challenges
  - Historic Building (USAFA wanted no visual interruptions)
  - Heavy winds and large hail in area also directed against using crystalline panels in this application
  - Construction of building left no room for system wiring to basement of 6 story facility. We routed conduit and wire via elevator shaft and provided shunt trip roof mounted breakers to isolate power in the event of alarm.

Photovoltaic System and Components Phase 1

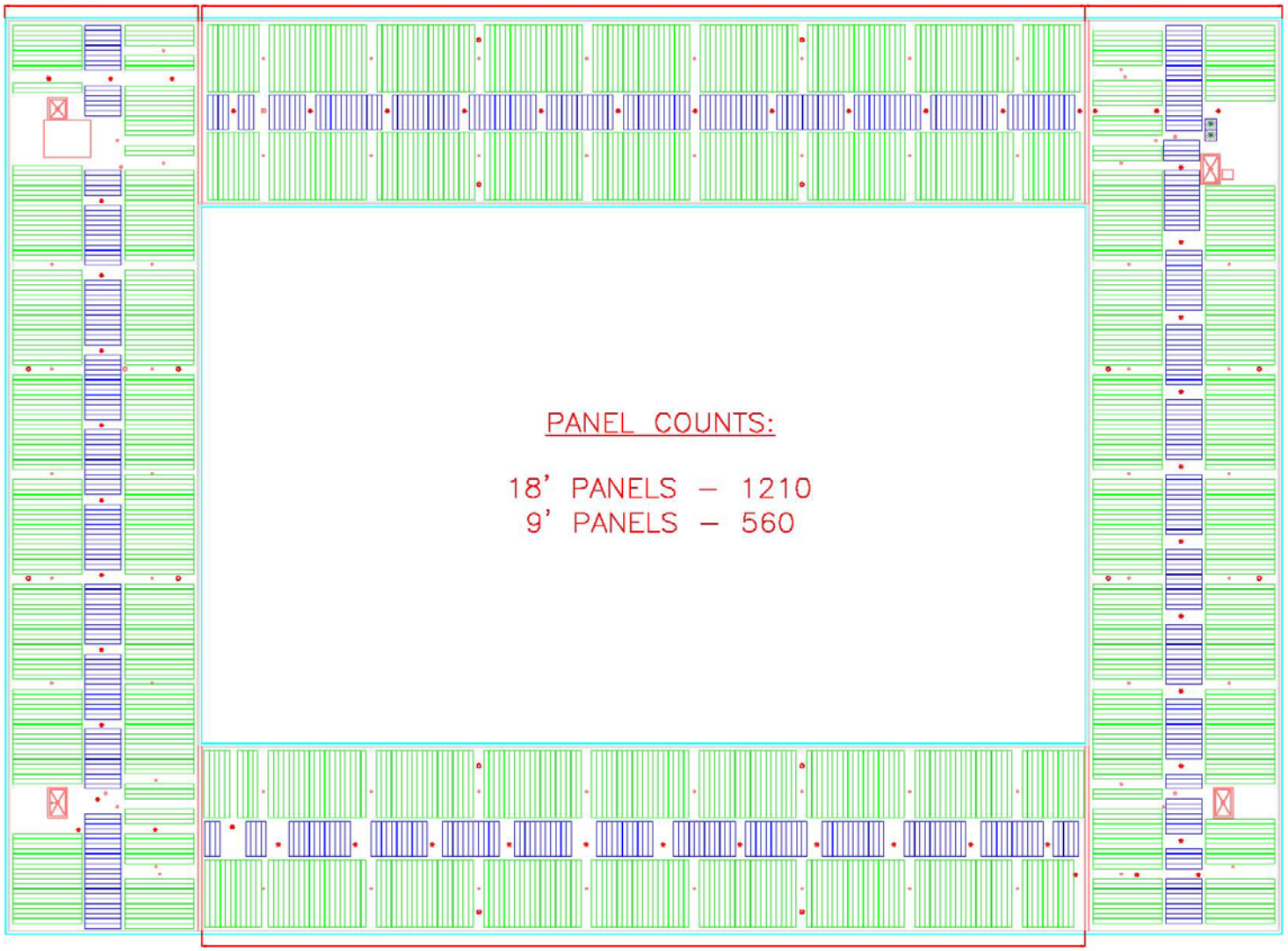
- Total installed production capacity: 212.320 KW DC
- Panels type and quantity:

    - Unisolar Thin Film Amorphous Silicon Panels
    - 1210 – Power Bond PVL-144 (144 watts each)
    - 560 – Power Bond PVL-68 (68 watts each)

2 ROWS 18' PANELS: 154 & 143
PANELS, 27 STRINGS OF 11
1 ROW OF 9' PANELS 144 PANELS,
9 STRINGS OF 16

2 ROWS OF 18' PANELS 154 PANELS, 28 STRINGS OF 11
1 ROW OF 9' PANELS, 144 PANELS 9 STRINGS OF 16

2 ROWS 18' PANELS: 154 & 143
PANELS, 27 STRINGS OF 11
1 ROW OF 9' PANELS 144 PANELS,
9 STRINGS OF 16



2 ROWS OF 18' PANELS 154 PANELS, 28 STRINGS OF 11
1 ROW OF 9' PANELS, 128 PANELS 8 STRINGS OF 16

SOPRASOLAR

SOPREMA

310 QUADRAL DRIVE
WADSWORTH, OHIO 44281
(330) 334-0066

TITLE			
USAFA – Vandenberg Hall max PV Layout			
SCALE	DWN	CHK	APPROVAL DATE
1/16= 1'	TM	GP	04/22/10
DRAWING NUMBER			REV
----			1

Photovoltaic System and Components Phase 1

- Inverters type and quantity:
    - Solectria – Grid Tied Commercial Inverters
    - 2 – PVI 95 KW
    - 2 – PVI 15 KW

Photovoltaic System and Components Phase 1

System Efficiencies

- Total system efficiency of 84% (based on actual field testing)
- Inverter efficiency = 96% (conversion of DC power to AC)

- Calculated Production
  - Expected at 305,268 (kilowatt hours) year 1, based on irradiance factor of 1437 kWh AC per DC watt for Colorado Springs.

Photovoltaic System and Components Phase 1

- Panel Characteristics
  - High Temperature and Low Light Performance
  - Bypass diodes for Shadow Tolerance
  - 80% Output Power maintained at 25 years
  - Tolerant from -40 degree F and 185 degrees F
  - .2” thick for minimal to no visual presence

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Vandenberg Hall Roof Waterproofing System

Application over existing granule surface modified bitumen membrane and roofing assembly:

- Base Coat = Alsan RS 230 (75mil)
- Reinforcement = Alsan Polyfleece (fully embedded)
- Top Coat = Alsan RS 230 (40mil)

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

Successfully Demonstrating an Integrated Roofing and BIPV Solution for an Historic Building Renovation at the United States Air Force Academy • Abstract Number: 12623

QUESTIONS?